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PARAPET STRUCTURE FROM SPECIAL SHAPED TRC BLOCKS

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Abstract.

The paper describes innovative parapet solution based on special shaped blocks made form textile-reinforced concrete - TRC. The blocks are designed for a placement at the parapet of building with a flat roof. The solution is appropriate for buildings with precast-concrete bearing structure by following the principle of precast technology (short construction time, minimal technological pauses). However, presented parapet TRC blocks can be used for energy efficient buildings as well in combination with thick layers of thermal insulation. The technical solution was registered as utility model no. CZ27642(U1).

Keywords: Concrete, parapet, prefabrication, roof, TRC.

1. Introduction

Nowadays, the emphasis is on energy savings in the field of building construction. The solution of building envelope details is important for contemporary design of buildings. An important part of this issue is the solution of the detail of flat roofs of buildings in the form of a low parapet wall. For buildings whose load-bearing structure consists of precast frame construction system, the parapet wall design is an important part of the overall design. The main advantage of precast technology is the minimization of wet processes on site which resulting to short construction time. In order to minimize the wet processes in precast construction systems, it is desirable that the parapet wall structure should also be prefabricated. However, this assumption is often not fulfilled, because at the present time the construction of the parapet wall in precast frame systems is commonly solved in the form of a masonry wall from various materials. In some cases, the parapet wall is in the form of a specially modified beam which combines the function of supporting the ceiling structure (specially adapted bearing girder) with the function of the parapet wall. However, such prefabricates usually represent a distinct architectural element (not suitable for most buildings) and at the same time almost do not consider the problem of linear thermal bridges (it cannot be used for modern energy efficient buildings). However, the requirement to minimize thermal bridges is one of the key parameters of the design of building envelope structures in today's building construction.

The solution currently used for the construction of a parapet wall on a flat roof in the form of aămasonry wall (mentioned above), presents several disadvantages. This is especially addition of another wet process into site construction which resulting to reduction of efficiency and speed of construction (not exploiting the potential of precast technology). Another significant problem is the risk of deformation of the masonry parapet wall (displacement due to shear stress in masonry) over time, which is often associated with aăfailure of the roof waterproofing layer. The parapet made in the form of aăspecially modified beam (specially adapted bearing girder) is a more suitable solution in terms of in situ efficiency but these elements are always part of standardized construction systems with predefined dimensions (the possibilities of using are limited due to architectural design). Another problem may be the high weight of the parapet bearing beam and the resulting complications in terms of handling the precast.

2. Parapet structure from special shaped TRC blocks

The above-mentioned disadvantages of existing parapet structures of flat roofs of buildings based on precast frame system (masonry and parapet bearing beams) are largely eliminated using specially shaped parapet blocks made of textile reinforcement concrete (TRC) [1]. The essence of the parapet block is that it is made of precast reinforced concrete with an optimized (lightweight) shape solution with aăcrosssection in the shape of the letter "L". The vertical wall of the parapet block is formed by a thin plate (30ămm thick), which is reinforced by reinforcing ribs (50×100 mm) at distances of $0.7 - 0.8$ m. The stiffening ribs comprise a bending reinforcement. The low plate thickness between the reinforcing ribs is made possible using high-performance concrete (HPC) in combination with textile reinforcement (TRC). The bottom horizontal slab of the block has a variable thickness which increases towards the centre of the block (thickness $30 - 80$ mm). The lower horizontal plate is made of TRC and, like the vertical plate, is reinforced with reinforcing ribs (50×100 to 137 mm) spaced $0.7 - 0.8$

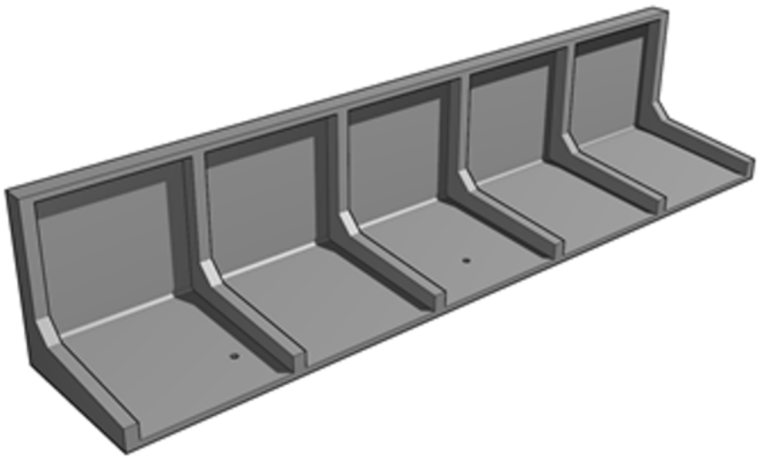

Figure 1. Special shaped parapet block (visualization).

m apart. These ribs, together with the ribs of the vertical plate, form an "L" -shaped frame structure with reinforcement in the centre of the block. The variable thickness of the horizontal slab is advantageous both in terms of precast technology (concreting will take place from the outer surface of the vertical slab) and in terms of better stability of the shaped piece (lower centre of gravity).

The parapet block is equipped with a horizontal cross rib (30×100 mm) at the top, which serves for anchoring of the flashing structure (through the spacer profile). The rib on the top of the parapet block also has a reinforcing function in terms of the horizontal load on the parapet wall (wind pressure, suction, anchoring of other structures). To ensure the fixation of the position, the block is equipped with three holes in the lower horizontal plate, which are used for anchoring the block to the ceiling panel of the frame system.

The shape-optimized "thin-walled" design of the parapet block is advantageous both in terms of minimizing the weight of the precast element during transportation and subsequent handling on site. At the same time, it is also advantageous the reducing of overall vertical load on the bearing structures and foundations of the building. The subtle optimized shape of the precast block using TRC is also advantageous in terms of eliminating thermal bridges. Only a minimal cross-section of a part of the supporting structure penetrates the thermal insulation envelope of the building. In fact, it is not a thermal bridge, because the parapet construction must always be thoroughly insulated around its perimeter. This design predetermines the parapet block for use in energy efficient buildings. For handling by lifting means, the block will be equipped with countersunk threads for screwing in the anchorages. These threads will be located on the upper surface of the horizontal reinforcing rib at the position of the vertical reinforcing ribs.

3. Description of the functional principle

Figure 3 shows the installation of the precast parapet block (no. 1) on the ceiling structure of a precast concrete frame construction system comprising ceiling panels (no. 2) and beams (no. 3). The parapet block (no. 1) is secured (fixed) against horizontal movements by anchoring at the anchor holes (no. 4). The lower horizontal slab of the parapet block (no. 5) is"weighted" by a layer of gravity concrete (no.ă6), which thus acts as a stabilizing layer. At its lower left edge, the parapet block (no. 1) is separated from the concrete layer forming a gradient (no. 7) by means of an inserted thermal insulator strip (no. 8), which eliminates the transfer of horizontal deformations of the concrete layer due to longitudinal thermal expansion.

On the upper horizontal reinforcement rib of the parapet block (no. 9) is an anchored construction of the flashing (no. 10). The vertical panel of the parapet block (no. 11) is supplemented by an additional thermal insulating layer (no. 12), which compensates for the higher thermal conductivity coefficient HPC (compared to the adjoining masonry of the external cladding (no. 13)). An additional thermal insulation layer (no. 11) is connected to the thermal insulation system of the facade cladding (no. 14), which is tightened up to the thermal insulation under the flashing (no. 15). From the inside of the roof, a vertical layer of thermal insulator (no. 16) is anchored to the parapet block. This layer follows the thermal insulation of the flat roof (no. 17). The thickness of the vertical thermal insulation (no. 15) is designed to overlap the reinforcing rib (no. 18) of the parapet block.

Figure 4 shows precast parapet block (no. 1) which forms the supporting structure of the parapet shown in Figure 3. The parapet block (no. 1) is characterized in that it is made in the cross-sectional shape of the letter"L", where the thin vertical plate of the block (no. 11) is reinforced with ribs (no. 18). The vertical ribs are reinforced at the point of connection

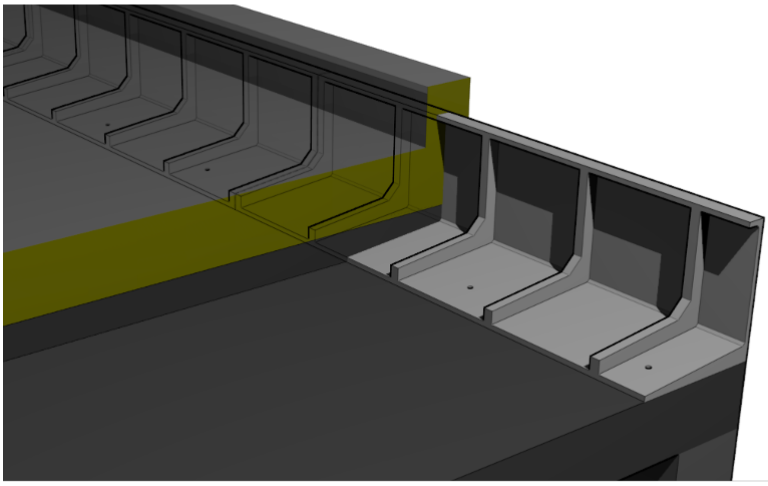

Figure 2. Installation of special shaped parapet block on the building (simplified visualization).

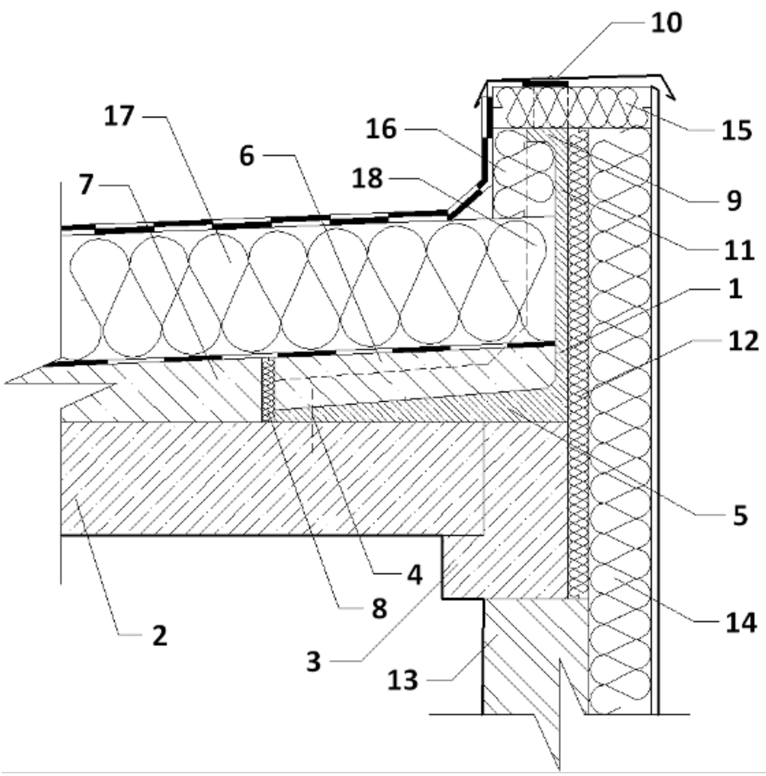

Figure 3. Example of parapet block installation on the ceiling structure of precast concrete frame construction system. *Notes*: 1 - parapet block, 2 - reinforced concrete ceiling panel, 3 - reinforced concrete beam, 4 - anchoring of parapet block, 5 - horizontal part of parapet block, 6 - monolithic concrete - layer forming a gradient and stabilizes the parapet block, 7 - monolithic concrete - layer forming a gradient, 8 - dilatation, elastic strip, 9 - the upper part of the parapet block, 10 - anchoring of parapet block, 11 - vertical part of parapet block, 12 - lower thermal insulation layer (compensation for reinforced concrete elements), 13 - filling masonry of perimeter wall, 14 - main thermal insulation layer (ETICS), 15 - insulation of parapet extruded polystyrene (XPS), 16 - insulation of parapet block, 17 - conventional roofing layers of flat roof, 18 - reinforcing rib of parapet block

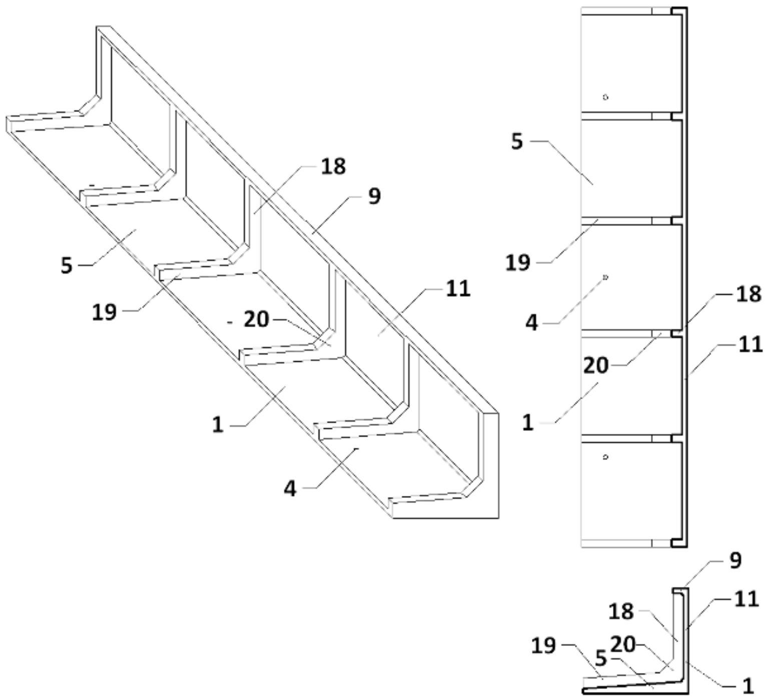

FIGURE 4. Precast parapet block. *Notes*: 1 - parapet block, 4 - anchoring of parapet block, 5 - horizontal part of parapet block, 9 - the upper part of the parapet block, 11 - vertical part of parapet block, 18 - vertical reinforcement rib of parapet block, 19 - horizontal reinforcement rib of parapet block, 20 - rib reinforcement.

to the ribs of the horizontal plate (no. 19) by triangular haunches (no. 20) and together with the reinforcing ribs of the lower horizontal plate (no. 19) form"L" frame structure. The solved parapet block (no. 1) is characterized in that it comprises a lower horizontal plate (no. 5) of variable thickness which increases towards the centre of the precast. This plate is reinforced with ribs (No. 19) which have an increasing thickness towards the centre of the prefabricated elements. The lower horizontal plate (no. 5) has three holes (no. 4) for anchoring the precast to the ceiling panel of the framework system. The parapet block (no. 1) is provided with aătransverse rib (no.ă9) at the top of the vertical plate (no. 11), which serves to anchor the parapet block flashing structure and to reinforce it in terms of horizontal loading.

4. CONCLUSION

The technical solution of the parapet block for flat roofs described in the paper was registered as a utility model no. CZ27642(U1). The block is intended primarily for energy-efficient buildings based on precast frame construction systems. However, it can be used without further modifications for parapet solutions in other building construction systems (e.g. masonry buildings with precast concrete ceiling), where the advantage of the precast technology will be beneficial. The parapet block is the next element used for construction details in buildings, expanding the existing set of thin-walled precast elements, developed at the Faculty of Civil Engineering CTU in Prague [2–4]. A potential industrial partner for production is currently being searched. Testing of mechanical properties is planned after the production of the first prototype series - based on the results, the final dimensions of the elements for serial production will be optimized.

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